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VI. Distribution of Man. Relation of History to Geography.

1. Effect of structure and climate on man's development. 2. Growth of civilization in hot, temperate, and cold countries. 3. Relation of mountains to the early development of man. 4. Relation of protected river valley, of islands, to early civilization. 5. Value of forest regions; of prairie regions to man's development. 6. Regions of earth's surface best adapted to early development of civilization. 7. Present geographical distribution of man according to advancement. 8. Location of white, yellow, and black types. 9. Distribution of tribal governments, of monarchies, of republics. 10. Conditions for the development of a republican form of government.

References: Herbertson, *Man and His Work; an Introduction to Human Geography.*

Syllabi on Applied Mathematics

George W. Myers

It is a matter of common observation and the occasion of no little concern to schoolmen that the brightest mathematical students, when trained exclusively by text-book methods, are powerless to apply their mathematical knowledge to practical affairs. So soon as meaning is attached to symbols many expert mathematicians, indeed, are thrown into hopeless confusion. The foes of mathematical study in the schools have no difficulty, therefore, in finding an abundance of examples to substantiate their contention that mathematics is the most useless of all studies. It is believed that this deplorable condition has been brought about largely by the friends of mathematical study in aiding, by practice if not by precept, in the isolation of mathematics from other subjects of study, thereby divorcing mathematics from its applications and treating it as so much pure logic.

No thoughtful scientist can desire for a moment to discredit the value of the work of the pure mathematician. The history of science shows too well how likely the results of the mathematical logician are to find important application in the realm of useful knowledge, and how great the service to science is which these applications sometimes render. The application of the theory of the conic section to the planetary orbits, after Kepler found these orbits to be conics, will suffice to show how the results of abstract mathematical research have advanced scientific knowledge farther at a single stride than centuries of patient observational inquiry has been able to do, before the discovery of the applicability of the theory. But this same history proves that mathematical advance has much more frequently been brought about by the solution of problems met in the pursuits of natural science than has the discovery of new possibilities of applying mathematics brought about scientific advance. Furthermore, comparatively few who study mathematics in the public schools ever become, or desire to become, mathematical experts in any high sense. Most persons study these branches in the hope that they will be of help in the mastery of other fields of mental activity. To these persons mathematical study is of value chiefly in defining and clarifying the ideas, and in organizing and relating the facts and phenomena of the physical world. It is thought, therefore, that the mathematical sciences will take on a newness of life by bringing the elementary stages of their study back to the original mooring, by presenting the foundation principles as means of revealing certain aspects of the world of physical phenomena.

But as all definite ideas must reach the mind through the senses, even the prospective mathematical specialist can best begin his study by laying a broad and solid foundation from materials drawn from the world of concrete phenomena. He is able thus to lay a firmer and more enduring hold on those central truths of his science, from which his later resources are largely to be drawn. This method of approach, by exalting psychological above logical requirements, conforms to the pedagogical principle that the determining factor for both matter and method is the learning mind rather than the subject of study. The needs of both a general and a special training are thus seen to be identical, so far as the foundation is concerned.

In the following syllabi the aim has been to make the needs of the learning mind the organizing idea. No attempt has been made, therefore, to distribute the subject-matter in any mutually exclusive way under the various special headings. What is suggested in the astronomical syllabus is quite as much mathematics as astronomy. The class-work will be based as largely as possible under the circumstances upon observational data taken in the open field, or under the open sky, by the members of the training class.

It is not intended to teach upon all topics suggested in the accompanying outlines during the summer. Such special topics will be selected for study as seem best suited to the needs and wishes of the class after it has met.

Syllabus on Astronomy

Lecture and Lesson I.

Topic: A Preliminary Survey of the Sky.

1. Rules for recording.
2. The fifteen brightest stars visible in Chicago. Magnitude in sense of brightness defined.
3. Colors of these stars.
4. Allineations and triangulations on neighboring stars for purposes of identification.
5. Various methods in use for designating the stars.
6. The constellation of the Great Bear. The Dipper. The Pointers. Polaris. The Guards. The Lesser Bear. The Dipper in the Lesser Bear. "Measuring Sticks" for star distance.
7. The constellation of Cassiopiæ's Chair. The equinoctial colure. Siderial time. Determination of the meridian.
8. The zodiacal constellations.
9. Directions for observational studies.

Lecture and Lesson II.

Topic: Observational Study of the Sun.

1. Study of solar heat. (a) Heat at focus tested experimentally for a terrestrial source. Laws I., II., and III. (b) Heat at focus for solar rays. Laws applied to sun's heat.
2. Sunlight studied experimentally. Images formed by interstices between leaves. (a) Sunlight compared with artificial light. (b) Sunlight compared with moonlight or starlight.
3. Other measurable effects of solar rays. Chemical effects. Magnetic effects.
4. Observational study of the globe of the sun.
5. Positions and motions of the sun.
6. Make a drawing from day to day of a sun-spot.

References: Young's *The Sun;* Ball's *Story of the Sun.*

Lecture and Lesson III.

Topic: Observation and Study of the Constellations, Stars, Time, etc.

1. The zodiacal constellations and signs. Uses.
2. The zodiacal light. Counter glow.
3. Other conspicuous constellations.
4. Estimation and determination of time, from star observations.
5. To locate the meridian of a place astronomically.
6. Apparatus needed.

References: Upton's *Star Atlas;* Schurig's *Atlas;* Poole's *Planisphere;* Young's *Uranography.*

Lecture and Lesson IV.

Topic: Observational Study of the Moon. (Opera glass.)

1. Look up almanac date of new moon. Begin observing moon as soon thereafter as possible.

2. Face appearance (both day and night). (a) Color and color variation of moon's face. (b) The crescent itself. (c) Markings upon the moon's face drawn.

3. The moon's motions. (a) The motion toward the west. (b) The motion toward the east. (c) The motion of rotation.

4. The moon's path among the stars and orbit.

5. Points of the compass. Measure the moon's altitude and azimuth.

6. Estimate the moon's right ascension, declination, longitude, and latitude (celestial). Equinoxes.

7. What light do your lunar studies throw on the following from Barnaby Rudge? "It was a fine dry night, and the light of a young moon, which was then just rising, shed around that peace and tranquillity which give to evening time its most delicious charm."

References: Howe's *Descriptive Astronomy;* Poole's *Lunar Atlas.*

Lecture and Lesson V.

Topic: Observational Study of Planets, Bright Stars, Meteors, Clusters, etc.

1. Methods of naming these objects.
2. Colors of planets and stars.
3. Brightness and steadiness of light.
4. Positions of planets from week to week.
5. Location and study of meteor paths.
6. The planets themselves.
7. Look up a conjunction in the almanac, watch, and describe it.

References: Ledger's *The Sun; Its Planets, etc.;* Jayne's or Ayer's Almanac.

Lecture and Lesson VI.

Topic: The Common Almanac.

1. Brief description of standard ephemerides.
2. Compilation of the common almanac.
3. Use of the almanac.
4. Column headed "Aspects of the planets, etc."
5. Compare sun's declination for July, 1900, of Old Farmer's Almanac with Ephemeris values.
6. Examination and explanation of Calendar page of Jayne's Almanac.
7. Historical items relating to common almanac.

References: Jayne's, Ayre's, *The Old Farmer's*, the *Connecticut*, or the *New England* almanacs. Articles on Almanac in *Popular Astronomy*, Vols. II. and III., by MacFarland.

Lecture and Lesson VII.

Topic: Observational Studies of Variables, Double Stars, the Milky Way, Zodiacal Light.

1. Stars of Great Dipper and Little Dipper arranged in orderly sequence of brightness.
2. A bright short period, variably arranged in a sequence with neighboring stars.
3. Color and color change from one time of day to another, from star to star.
4. Doubles identified and studied.
5. Trace and dilineate the Milky Way.
6. Identify and examine nebulæ and clusters. (Telescope.)
7. Study the constellation of Leo with an opera glass or a small telescope.
8. Mars' and Venus' change in brightness dependent upon the position in orbit.

References: Bowen's *Astronomy by Observation*, and Serviss' *Astronomy with an Opera Glass.*

Lecture and Lesson VIII.

Topic: Home-made Apparatus, Globes, Maps, Charts, etc.

(1), Meridian mark; (2), Gnomon; (3), Crude Altazimuth; (4), Tycho's quadrant; (5), The Cross-bar; (6), Transit Tube; (7), Home-made equatorial; (8), Foucault's pendulum and model; (9), globes filled out by student; (10), Maps and charts drawn by student; (11), Frame to catch image of sun; (12), Rogers' star finder; (13), Latitude box; (14), Frame to show varying brightness of solar disc.

Syllabus on Arithmetic

I. Qualifications of the teacher of arithmetic.

1. In mathematics. 2. In physical or natural science. 3. In psychology. 4. In pedagogy.

II. Subjects to be thoroughly taught.

1. Combinations of numbers up to 100. 2. The fundamental operations. 3. Fractions, common and decimal. 4. Greatest common divisor; least common multiple and factoring. 5. Compound numbers taught objectively. 6. Simple proportion and but little, if any, compound proportion. 7. Percentage and the more common cases of interest.

III. Subject matter, which should be omitted, or shortened, or postponed.

1. Omit all of the apothecaries' weight and English money except tables. 2. Most of commercial arithmetic and compound propor-

tion. 3. Stocks and bonds, insurance, exchange, partial payments, annuities, etc. 4. Replace nearly all of what is called advanced arithmetic by algebra and geometry.

IV. Other matters which should be dropped or abandoned.

I. Unnecessary definitions and rules not reached as generalizations. 2. All artificial problems. 3. Long and tedious addition and subtraction problems. 4. Abstract problems depending upon very small fractions. 5. All mathematical conundrums and problems whose language is beyond the pupils. 6. All but a reasonable number of " money problems," and most purely technical problems. 7. The time thus saved should be put upon practical applications of algebra and geometry.

V. How should arithmetical subjects be taught?

(1) Objectively, (2) with mathematical laboratory, and (3) through measurement.

VI. Various ways in which arithmetical processes may be taught.

(1) By teaching figures instead of numbers; (2) by using objects of no intrinsic interest; (3) by mersuring. (See *A Study in Measuring Quantity,* under Topic V.)

Syllabus on Geometry

Unless other than logical claims can be urged in favor of the study of geometry its place in school curricula may well be taken by more useful studies. That geometry has a high practical value is clear from the fact that its central truths are indispensable to successful study in any of the following lines:

1. In nature study; (2) in surveying, both plane and geodetic; (3) in the theories of equilibrium and of motion; (4) in strength of materials; (5) in hydraulics, and (6) in astronomy.

Outline of Work Needed to Interpret Facts Relating to the Chosen Tract

1. Introductory questions. 2. Problems in pacing. 3. Form of tract selected for study, both as a whole and as to its parts. 4. Area of surfaces upon it. 5. Topographical features. 6. Ranging and measuring lines upon the tract. 7. Areas of wind surfaces of trees and structures upon it. 8. Test any structures as to orientation and stability. 9. Value of some of the large trees for lumber. 10. Rate at which streams are transporting soil and silt to outlets. 11. Cost of draining and filling. 12 Cost of removing the soft earth and puddling the bed of a pond for an artificial lake.

In connection with astronomy, geometry will furnish valuable information of the sort suggested under the following headings:

1. Location and fixation of a reference meridian. 2. Determination of the latitude and longitude of points of reference. 3. Amount of solar heat incident upon the surface of the tract hourly, daily, yearly. 4. Energy to which the above is equivalent. 5. Quantity of sunlight incident upon the tract. 6. Diurnal variations and disturbances of the magnetic needle. 7. Study of *seiches* in Lake Michigan. 8. Problems relating to the strength of timber from the tract.

Aid Requested from Other Departments

All departments are requested to aid in the collection of material.

From physics: An experiment to show the amount of solar heat and light incident upon a given area of the earth's surface in a given time.

From botany: Explanation as to how to obtain the evaporating surface of the foliage of a green tree.

Geometry must be taught more with reference to its central principles and less with a view to securing logical beauty and completeness. Nearly all of geometry is based upon half a dozen or so fundamental principles; these principles stated and discussed.

The order in which the principles of geometry should be taught is suggested by the subdivision of— 1. Intuitional geometry. 2. Observational geometry. 3. Formal geometry.

Each of these branches will be explained and discussed fully.

Syllabus on Algebra

An arrangement of subjects similar to the one given here would furnish a much better course of study in mathematics than does the customary sequence.

Number. Arithmetic. Arithmetic and algebra. Algebra. Algebra and analytic geometry. Intuitional geometry. Observational geometry.

Observational geometry (with simple reasoning). Formal geometry and beginning trigonometry. Trigonometry, with modern geometry.

The guiding principle is to begin the new subject always before the old one which leads to it has been completed.

Algebra is only arithmetic extended by the introduction of the following new ideas: 1. The use of letters to represent generalized number. 2. The use of the minus sign as a symbol of quantity. 3. The equation as a tool for the solution of problems. 4. The use of fractional and negative exponents. 5. The use of irrational numbers. 6. The use of the variable and its limit.

The sequence and manner of presenting these new ideas should be such that the motive for each shall be felt from the beginning. This can be done best by taking the equation as the organizing and developing idea for both matter and method in algebra.

Many of the operations of arithmetic must be restudied in algebra in the light of these new ideas.

The subject of factoring, which is so important and so troublesome to the learner, as also to the teacher, may be developed easily from three simple principles.

The theory of exponents and logarithms should be shown to rest upon these four elementary principles:

$$a^n \times a^m = a^m + {}^n;\ a^m/a^n = a^{m-n};\ (a)^{mn} = a^{mn},$$
$$\text{and } (ab)^n = a^n b^n,$$

where ^{m} and ^{n} may be integral, fractional, positive, or negative. These principles should be carefully taught and their true relations to these theories clearly seen by the pupil.

The solution of the quadratic equation, and particularly of simultaneous equations depending upon quadratics, is very greatly aided by graphical methods.

Practical applications to second degree simultaneous equations arising out of practical problems.

Practical applications arising out of the geometry and trigonometry needed to render the selected area intelligible to grammar and high school pupils.

The formulas for stresses in beams, in columns, for flow of water, and for other subjects treated, in the strength of materials and hydraulics, furnish many instructive applications of algebraic principles, and should be freely drawn upon by the teacher.

Mathematics in the Primary Grades

Gertrude Van Hoesen

The chief purpose of the following part of the course in mathematics is to show the place and function of arithmetic in the primary grades. The outline presents various phases of work illustrating how essential an understanding of the fundamental principles and processes of arithmetic is in the most common affairs of life. Within the school, it is quite as essential that the child's work in arithmetic should be closely related to his life and interests. But it must be proved that such work is not only more interesting to the child, but also more educative.

The work in the outline below appears in an unrelated form, and is intended only for use as reference in the classroom discussion.

Discussion of methods of teaching numbers:

There are three ways—one prevailing, one in partial use, one which has never been fully carried out in any school.

The first method includes the notation and numeration of figures; adding, subtracting, multiplying, dividing; committing tables to memory; doing isolated problems; following a so-called logical order from adding to banking; learning rules and following them; learning definitions without understanding them.

In the second method blocks are used and other objects, such as shoepegs, sticks, and colored dishes; this includes counting, marking, and picturing. The objects have no interest beyond their mere use,